

CLAIMS

What is claimed is:

1. A method for modulating primordial germ cells numbers in an avian embryo, the method comprising immunizing a female bird with an antigen associated with primordial germ cells, whereby an egg produced by the female bird comprises a sufficiently high concentration of antibodies specific for the antigen to modulate numbers of endogenous PGCs in an avian embryo present within in the egg.
2. The method according to Claim 1, wherein the female bird is selected from the group consisting of chicken, turkey, duck, quail, and sand hill crane.
3. The method according to claim 3, wherein the female bird is a chicken.
4. The method according to Claim 1, wherein the antigen comprises an epitope of a polypeptide selected from the group consisting of SSEA-1, VASA, EMA-1, germ cell-less, dead end, nanos, stella, fragilis, and DAZL.
5. The method of claim 1, wherein the immunizing step results in a decrease in primordial germ cell numbers in the avian embryo.
6. The method of claim 1, wherein the immunizing step results in an increase in primordial germ cell numbers in the avian embryo.
7. A method for modulating primordial germ cell development in an avian embryo, the method comprising immunizing a female bird with an antigen associated with primordial germ cells, whereby an egg produced by the female bird comprises a sufficiently high concentration of antibodies specific for the antigen to modulate development of PGCs in an avian embryo present within the egg.
8. The method according to Claim 7, wherein the antigen comprises an epitope of a polypeptide selected from the group consisting of SSEA-1, VASA, EMA-1, germ cell-less, dead end, nanos, stella, fragilis, and DAZL.
9. The method according to Claim 7, wherein the female bird is selected from the group consisting of chicken, turkey, duck, quail, and sand

hill crane.

10. The method according to claim 9, wherein the female bird is a chicken.

11. The method of claim 7, wherein the immunizing step results in an inhibition of development of the primordial germ cells in the avian embryo.

12. The method of claim 7, wherein the immunizing step results in an enhancement of development of the primordial germ cells in the avian embryo.

13. A method for producing a chimeric avian, the method comprising:

- 10 (a) immunizing a female avian with an antigen associated with primordial germ cells;
- (b) producing an egg from the female bird, wherein the egg comprises a sufficiently high concentration of antibodies specific for the antigen to modulate PGC development, PGC numbers, or combinations thereof, in a recipient embryo present within the egg; and
- 15 (c) administering donor PGCs to the recipient embryo *in ovo* to produce a chimeric avian.

14. The method according to Claim 13, wherein the antigen comprises an epitope of a polypeptide selected from the group consisting of SSEA-1, VASA, EMA-1, germ cell-less, dead end, nanos, stella, fragilis, and DAZL.

15. The method according to Claim 13, wherein the donor PGCs are from the same avian species as the recipient embryo.

25 16. The method according to Claim 13, wherein the donor PGCs are from a different avian species as the recipient embryo.

17. The method according to Claim 13, further comprising incubating the chimeric avian to hatch.

30 18. The method according to Claim 13, wherein the female avian is selected from the group consisting of chicken, turkey, duck, quail, and sand hill crane.

19. The method according to Claim 13, wherein the donor PGCs are from an avian embryo selected from the group consisting of chicken, turkey, duck, quail, and whooping crane.

20. The method according to Claim 13, wherein the donor PGCs carry a pair of male determinative (Z) chromosomes.

21. The method according to Claim 13, wherein the donor PGCs carry a female determinative (w) chromosome.

22. The method according to Claim 13, wherein the administering is by *in ovo* injection.

23. The method according to Claim 13, wherein the donor PGCs are administered when the recipient embryo is between about stage IX according to the Eyal-Giladi & Kochav staging system and about stage 30 according to the Hamburger & Hamilton staging system.

24. The method according to Claim 13, wherein the donor PGCs are administered when the recipient embryo is after stage 14 according to the Hamburger & Hamilton staging system.

25. The method according to Claim 13, wherein the donor PGCs are selected from the group consisting of gonadal PGCs, blood PGCs, and germinal crescent PGCs.

26. The method according to claim 13, wherein the administering step is carried out by injecting the recipient embryo with blastodermal cells, and wherein the blastodermal cells differentiate into donor PGCs in the recipient embryo.

27. A method for increasing the proportion of male birds in a plurality of bird eggs, the method comprising:

- (a) immunizing a female bird with an antigen associated with primordial germ cells;
- (b) producing an egg from the female bird, whereby the egg comprises a sufficiently high concentration of antibodies specific for the antigen to modulate PGC development in a recipient female bird present within the egg;

- (c) administering male (ZZ) PGCs to the recipient female bird *in ovo*;
- (d) incubating the recipient female bird to hatch;
- (e) raising the recipient female bird to sexual maturity; and
- 5 (f) producing from the recipient female bird a plurality of bird eggs, wherein the proportion of male birds in the plurality of bird eggs produced by the recipient female bird is higher than would have been obtained in the absence of administering the male (ZZ) PGCs to the recipient female bird *in ovo*.
- 10 28. The method according to Claim 27, wherein the antigen comprises an epitope of a polypeptide selected from the group consisting of SSEA-1, VASA, EMA-1, germ cell-less, dead end, nanos, stella, fragilis, and DAZL.
29. The method according to Claim 27, wherein the donor PGCs are
- 15 from the same avian species as the recipient embryo.
30. The method according to Claim 27, wherein the donor PGCs are from a different avian species as the recipient embryo.
31. The method according to Claim 27, wherein the female avian is selected from the group consisting of chicken, turkey, duck, quail, and sand
- 20 hill crane.
32. The method according to Claim 27, wherein the donor PGCs are from an avian embryo selected from the group consisting of chicken, turkey, duck, quail, and whooping crane.
33. The method according to Claim 27, wherein the administering is
- 25 by *in ovo* injection.
34. The method according to Claim 27, wherein the donor PGCs are administered when the recipient embryo is between about stage IX according to the Eyal-Giladi & Kochav staging system and about stage 30 according to the Hamburger & Hamilton staging system.
- 30 35. The method according to Claim 27, wherein the donor PGCs are administered when the recipient embryo is after stage 14 according to the

Hamburger & Hamilton staging system.

36. The method according to Claim 27, wherein the PGCs are selected from the group consisting of gonadal PGCs, blood PGCs, and germinal crescent PGCs.

5 37. The method according to claim 27, wherein the administering step is carried out by injecting the recipient embryo with blastodermal cells, and wherein the blastodermal cells differentiate into donor PGCs in the recipient female bird.

10 38. A method for producing avian gametes from a second avian species in a first avian species, the method comprising:

- 15 (a) immunizing a female of the first avian species with an antigen associated with primordial germ cells, whereby an egg produced by the female comprises a sufficiently high concentration of antibodies specific for the antigen to modulate PGC development of a recipient bird of the first avian species present within the egg;
- (b) introducing donor PGCs isolated from an avian of the second avian species into the recipient bird of the first avian species;
- (c) incubating the recipient bird of the first avian species to hatch;
20 and
- (d) raising the recipient bird of the first avian species to sexual maturity, wherein the recipient bird of the first avian species produces gametes from the second avian species.

25 39. The method of Claim 38, wherein the antigen comprises an epitope of a polypeptide selected from the group consisting of SSEA-1, VASA, EMA-1, germ cell-less, dead end, nanos, stella, fragilis, and DAZL.

 40. The method according to Claim 38, wherein the first avian species and the second avian species are each selected from the group consisting of chicken, turkey, duck, quail, sand hill crane, and whooping crane.

30 41. The method according to Claim 38, wherein the first avian species and the second avian species are the same.

42. The method according to Claim 38, wherein the first avian species and the second avian species are different.

43. The method according to Claim 38, wherein the administering is by *in ovo* injection.

5 44. The method according to Claim 38, wherein the donor PGCs are administered when the recipient bird of the first avian species is between about stage IX according to the Eyal-Giladi & Kochav staging system and about stage 30 according to the Hamburger & Hamilton staging system.

10 45. The method according to Claim 38, wherein the donor PGCs are administered when the recipient bird of the first avian species is after stage 14 according to the Hamburger & Hamilton staging system.

46. The method according to Claim 38, wherein the PGCs are selected from the group consisting of gonadal PGCs, blood PGCs, and germinal crescent PGCs.

15 47. The method according to claim 38, wherein the administering step is carried out by injecting the recipient bird of the first avian species with blastodermal cells, and wherein the blastodermal cells differentiate into donor PGCs in the recipient bird of the first avian species.

20 48. A method for enhancing germ line transmission of a nucleic acid molecule in a bird, the method comprising:

- 25 (a) immunizing a female bird with an antigen associated with primordial germ cells, whereby an egg produced by the female bird comprises a sufficiently high concentration of antibodies specific for the antigen to modulate PGC development in a recipient bird present within the egg;
- (b) administering a plurality of donor PGCs comprising the nucleic acid molecule to the recipient bird under conditions sufficient to allow at least one of the plurality of PGCs to colonize a gonad of the recipient bird;
- 30 (c) incubating the recipient bird to hatch; and
- (d) raising the recipient bird to sexual maturity, wherein the

recipient bird produces gametes derived from the donor PGCs.

49. The method of Claim 48, wherein the antigen comprises an epitope of a polypeptide is selected from the group consisting of SSEA-1, VASA, EMA-1, germ cell-less, dead end, nanos, stella, fragilis, and DAZL.

5 50. The method according to Claim 48, wherein the recipient bird and the donor PGCs are each selected from the group consisting of chicken, turkey, duck, quail, sand hill crane, and whooping crane.

51. The method according to Claim 48, wherein the donor PGCs are from the same avian species as the recipient bird.

10 52. The method according to Claim 48, wherein the donor PGCs are from a different avian species as the recipient bird.

53. The method according to Claim 48, wherein the administering is by *in ovo* injection.

15 54. The method according to Claim 48, wherein the donor PGCs are administered when the recipient bird is between about stage IX according to the Eyal-Giladi & Kochav staging system and about stage 30 according to the Hamburger & Hamilton staging system.

20 55. The method according to Claim 48, wherein the donor PGCs are administered when the recipient bird is after stage 14 according to the Hamburger & Hamilton staging system.

56. The method according to Claim 48, wherein the PGCs are selected from the group consisting of gonadal PGCs, blood PGCs, and germinal crescent PGCs.

25 57. The method according to claim 48, wherein the administering step is carried out by injecting the recipient bird with blastodermal cells, and wherein the blastodermal cells differentiate into donor PGCs in the recipient bird.